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ABSTRACT

This report describes a study to determine the effect of training on accuracy in estimating angles. The study was part of a research program directed toward improving navigation techniques for low-level flight in Army aircraft and was made to assess the feasibility of visually estimating angles on a map in order to determine angles of drift. Eighteen subjects were randomly divided into a control group and two training groups. One group was trained using angles drawn on plain white cards and the other group used angles drawn on both cards and tactical maps. The groups estimated the size of angles ranging from 1 degree to 18 degrees. After training, it was found that the test performance of the two training groups on map items was significantly superior to test performance of the control group; on card items there were no significant differences between the two training groups and the control group. There were no significant differences between the two training groups on either card items or map items. The authors conclude that visual estimation of angles on maps appears to be a feasible technique for determining angles of drift. (DT)

Technical Report 65-8

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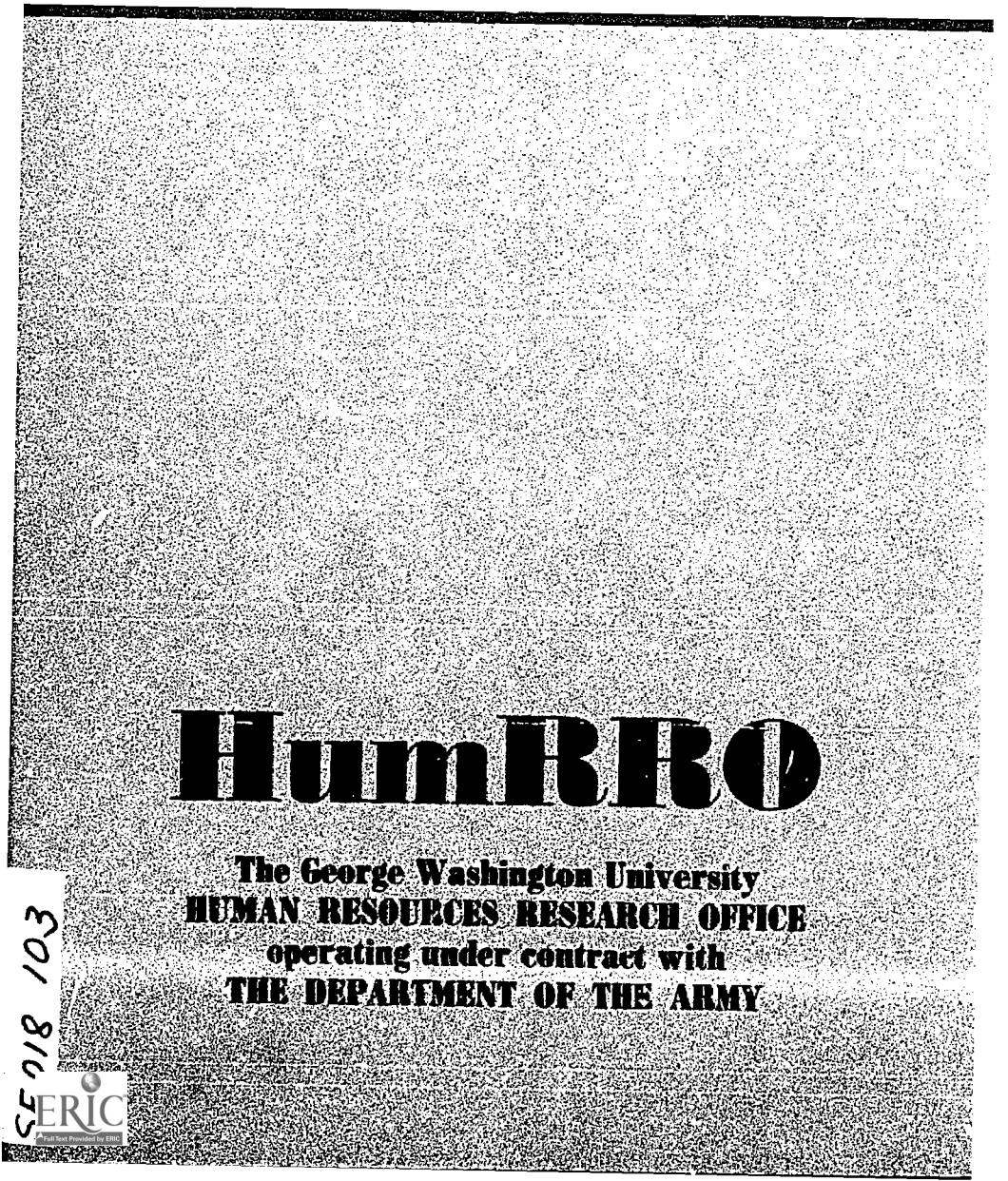
T. Gary Waller and Robert H. Wright

HumRRO Division No. 6 (Aviation)



The Effect of Training on Accuracy of Angle Estimation

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T. Gary Waller and Robert H. Wright

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HumRRO Division No. 6 (Aviation)
Fort Rucker, Alabama
The George Washington University
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FOREWORD

Task LOWENTRY has as its overall objectives the improvement of navigation techniques for low-level flight in Army aircraft and the development of training methods to teach these techniques to aviation personnel. Activities directed toward these objectives were begun by the Human Resources Research Office in 1961 at Fort Rucker, Alabama, under the sponsorship of the U.S. Continental Army Command.

In Subtask I, An Analysis of the Training Requirements for Low Altitude Navigation, factors influencing low altitude navigation have been defined, promising approaches explored, and development of training begun. In Subtask II, an experimental source text on Army aircraft navigation is being prepared.

As one of several Subtask I studies being conducted to determine the feasibility of certain navigation techniques at low altitude, the work reported here was performed to investigate the effect of training on the accuracy of angle estimation. Additional reports, in preparation, will deal with other elements of the problem of simplifying operational tasks of Army pilots, such as the smallest scale map that an Army aviator can use effectively, and the influence of map scale, subject task, and coordinate scale usage on map locational accuracy. Already published is a Consulting Report, *Pictorial Navigation Displays and Low Altitude Navigation*, by Robert H. Wright and Thomas G. Waller, April 1964. A general survey report on factors influencing Army low altitude navigation is also being prepared under LOWENTRY I.

Task LOWENTRY, Methods for Improving Navigation Training for Low-Level Flight, is being conducted by the Human Resources Research Office under Army Contract DA 44-188-ARO-2 and Army Project 2J024701A712 01, Training, Motivation, Leadership Research.

The LOWENTRY research is being performed at HumRRO Division No. 6 (Aviation), at Fort Rucker, Alabama, with Dr. Robert H. Wright as the Task Leader. The present Director of Research of the Division is Dr. Wallace W. Prophet; Dr. J. Daniel Lyons was Director of Research at the time the research was begun.

Military support for the study was provided by the U.S. Army Aviation Human Research Unit. Task LOWENTRY was begun when Lt. Col. Arne H. Eliasson was Unit Chief and continued while Maj. Donald J. Haid was Chief. Lt. Col. Berkeley D. More is the present Unit Chief.

MEREDITH P. CRAWFORD
Director
Human Resources Research Office

PROBLEM

In the navigation of aircraft, it is sometimes necessary for the pilot to determine the heading change or correction angle required to get back on course. This angle may be measured or estimated. Results of previous research indicate that measurement and certain types of estimation are not feasible during flight at low altitudes.

The present study was conducted to determine the effect of training on accuracy of angle estimation and the feasibility of using direct perceptual estimation to determine angles of drift.

RESEARCH PROCEDURE

Eighteen subjects were randomly divided into three groups--two training groups and one control group. One training group was trained in angle estimation using angles drawn on plain white cards; the other training group used angles drawn both on cards and on tactical maps in their training.

The two training groups were tested on angle estimation performance, were administered different training programs of approximately one-half hour, and then were tested again. One week later the training groups were given a third test; they were then provided with a job aid and tested a fourth time. The procedure for the control group was the same as for the training groups except that the control group did not receive any training.

RESULTS

The results indicated that:

(1) Before training, subjects in the training groups estimated angles of 1° to 18° on maps with a mean absolute error of 2.57° and a mean algebraic error of -0.20°.

(2) Training produced significant increases in accuracy of angle estimation for both training groups, with mean absolute error on maps after training found to be 1.34°. Mean algebraic error changed significantly to +0.43°.

(3) After training, the card items continued to be underestimated, whereas the map items tended to be overestimated.

(4) The improvement produced by training did not significantly decline after a one-week interval.

(5) The different training programs did not produce significantly different performance between the two training groups.

(6) A job aid consisting of reference angles of 5°, 10°, and 15° did not significantly improve performance on maps for either the training groups or the control group. For the training groups,

on the card items the job aid shifted the error from underestimation to slight overestimation of angle size.

CONCLUSIONS

It is concluded that direct perceptual estimation on maps appears to be feasible as a technique for determining angles of drift, and this ability can be improved by a small amount of training.

CONTENTS

The Effect of Training on Accuracy of Angle Estimation

INTRODUCTION

The objectives of the research being conducted under Task LOWENTRY at HumRRO Division No. 6 (Aviation), Fort Rucker, Alabama,[1] are to develop improved navigation techniques for low altitude flight and to develop training methods to teach necessary skills to aviator personnel.

In tactical environments Army aviators conduct aerial flights with obstacle clearances of 1 to 500 feet, at speeds of 35 to 250 miles per hour. Such low altitude flights subject the aviator to much higher task loadings than do flights at higher altitudes, and conventional nonradio navigation techniques are found to be inadequate at these levels. The pilot's time and attention must be divided between the navigation tasks and all the other tasks associated with controlling the aircraft, avoiding obstacles, and successfully completing specific missions. One approach to providing adequate low altitude navigation techniques and training is to reduce or simplify the tasks involved.

One of the pilot's navigation tasks is the determination of heading changes for correcting off-course situations. When a pilot finds himself off his planned route, he must determine a correction angle. This angle can be determined by measuring it on a map with a protractor, by computing it with a trigonometric relationship called the "rule of 60," or by visually estimating the size of the angle on the map. At low altitudes the pilot's task loading does not permit him sufficient time to measure an angle with a protractor, and available data[2] indicate that errors made using the "rule of 60" would be unacceptably high. Consequently, the pilot's best recourse may be to estimate a correction angle by visual reference to his map.

The experiment reported here was designed to investigate:

(1) The accuracy with which untrained subjects can estimate angles.

(2) The effect of training on the accuracy of angle estimation.

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[1]The term "U.S. Army Aviation Human Research Unit," which was used prior to 1 January 1965 to include both HumRRO staff and the Unit supporting military staff provided by the U.S. Continental Army Command, is now used, more specifically, to denote the military contingent of the Fort Rucker research group.

[2]United States Army Aviation Board, *Report of Test. Project No. AVN 4860.1/61 Phase III of Man Machine Environment Compatibility Studies and Test in Support of Surveillance Aircraft Development*, Fort Rucker, Alabama, 28 May 1962 (FOR OFFICIAL USE ONLY).

(3) The stability of training effects over a time period of one week.

(4) The relative effectiveness of two types of training materials, which differ in terms of their similarity to the criterion task.

(5) The effect of a simple job aid on the accuracy of angle estimation.

METHOD

Design and Procedure

Three groups were utilized in the experiment; two were training groups (A and B) and the third was a control group (C). The two training groups were tested on angle estimation performance, were administered a training program of approximately one-half hour, and then were tested again. The procedure for the control group was the same except that no training was administered.

The instructions given in the various testing and training situations are contained in the Appendix.

Subjects

Each of the three groups was composed of six subjects--three males and three females. The subjects were randomly assigned to the three groups, with the restriction that males and females be evenly divided among the groups.

All 18 subjects were personnel of the U.S. Army Aviation Human Research Unit. Seven of the nine males were enlisted men in the Army, one was a retired lieutenant colonel, and one was a civilian research assistant. Five of the nine females were secretaries, one was an administrative assistant, one was a librarian, and two were technical assistants.

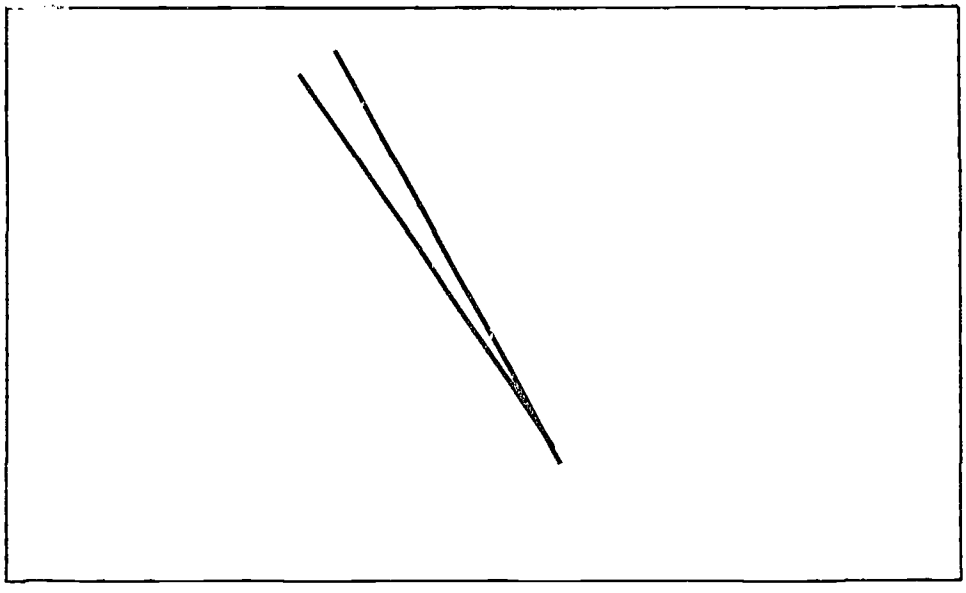
Three test forms were used in a counterbalanced arrangement for the first three tests. For each subject, the form used for the first test was used again for the fourth test.

Each test form contained 72 items bound in a loose-leaf notebook, one item per page. The 72 items were angles of 1° through 18° presented four times each. Each angle size was presented twice on plain white cards and twice on map sections of scale 1:250,000. The cards and the map sections were 5 inches wide and 8 inches long. An example of each type of item is shown in Figure 1.

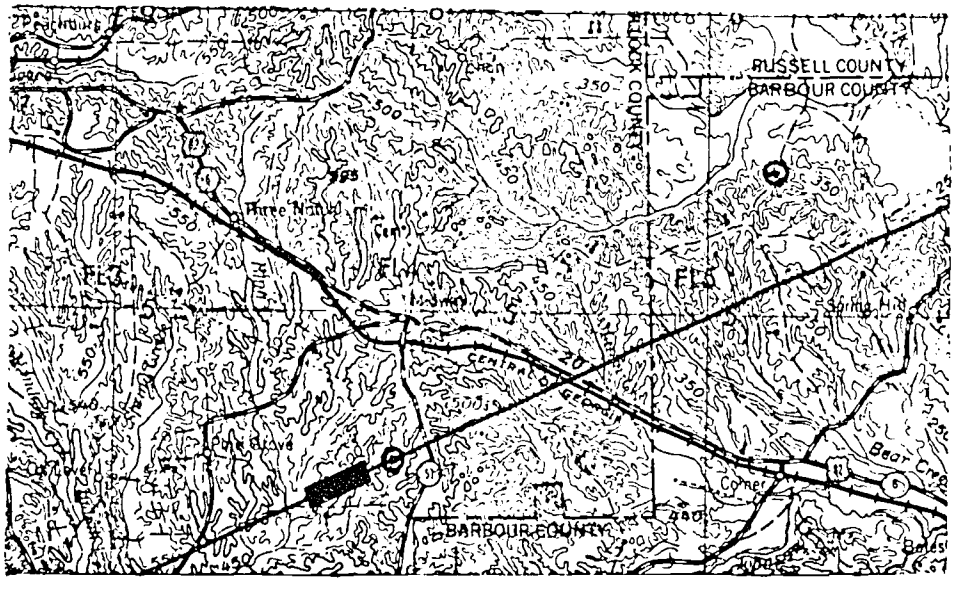
On card items, the angles were drawn with arms 4 inches long. On the map items, a straight line representing a navigation course line was drawn across each map section. The course line defined one side of the angle; the other side was indicated by a dot on the line and another dot off the line. A circle three-sixteenths of an inch in diameter was drawn around each dot. The distance between the dots was 4 inches.

On 18 of the 36 map angles, the off-the-line dot was clockwise from the course line and the origin dot, and on the other 18 map items it was counterclockwise. The position--clockwise or

AN EXAMPLE OF EACH TYPE OF TEST ITEM



Card Item



Map Item

Figure 1

counterclockwise--was randomly determined, with the restriction that half of the dots fall into each category.

Orientations of the angles on the cards and maps were balanced over 36 compass points spaced at 10° increments beginning at zero. Each angle size was presented twice on cards and twice on maps; the two presentations of each type of item were at least 100° different in orientation.

The order in which the 72 items were presented in a test form was randomly determined, with the restriction that adjacent items could not be the same angle size.

Training Materials

A different training book was developed for each training group. For the first group (A), all study items were drawn on cards. For the second group (B), half of the items were drawn on cards and the other half on maps.

Each training book began with instructions for the study session. Reference angles of 5°, 10°, and 15° were then pictured; the subject was allowed to study these pictures as long as he wished. Then 54 training items were presented, with each angle from 1° through 18° being shown three times.

The 54 training items were drawn exactly like the test items. Orientations were balanced across the 36 compass positions, with the restriction that two of the items for each angle size had to be at least 100° different in orientation. Order of presentation was randomized, with the restriction that no adjacent items could be the same angle size. For Group B, the card-map training group, the position of the dot on the map items was randomly determined.

The correct size of each angle was written on a tab that was placed face down near the bottom of the page. An example of a card training item is shown in Figure 2. A similar format was used for map training items. The subject wrote his estimate of the angle size on the answer sheet, then raised the tab and looked at the correct figure. If his estimate was correct, he proceeded to the next item; if incorrect, he drew a line through his response and wrote the correct answer beside it. Each subject was permitted to work at his own rate.

The Job Aid

A job aid, which is shown in Figure 3, was provided for use by all subjects on the fourth test. The job aid was a card 5 inches wide and 8 inches long on which reference angles of 5°, 10°, and 15° were drawn. The three angles had arms 2 1/2 inches long drawn as lines radiating from the same origin. The left arm was oriented at 360° and was common to all three angles.

For reference during the test, the card was placed in an upright position on a desk at a distance of approximately 28 inches from the subject's eyes.

AN EXAMPLE OF A PAGE OF THE TRAINING TEXT

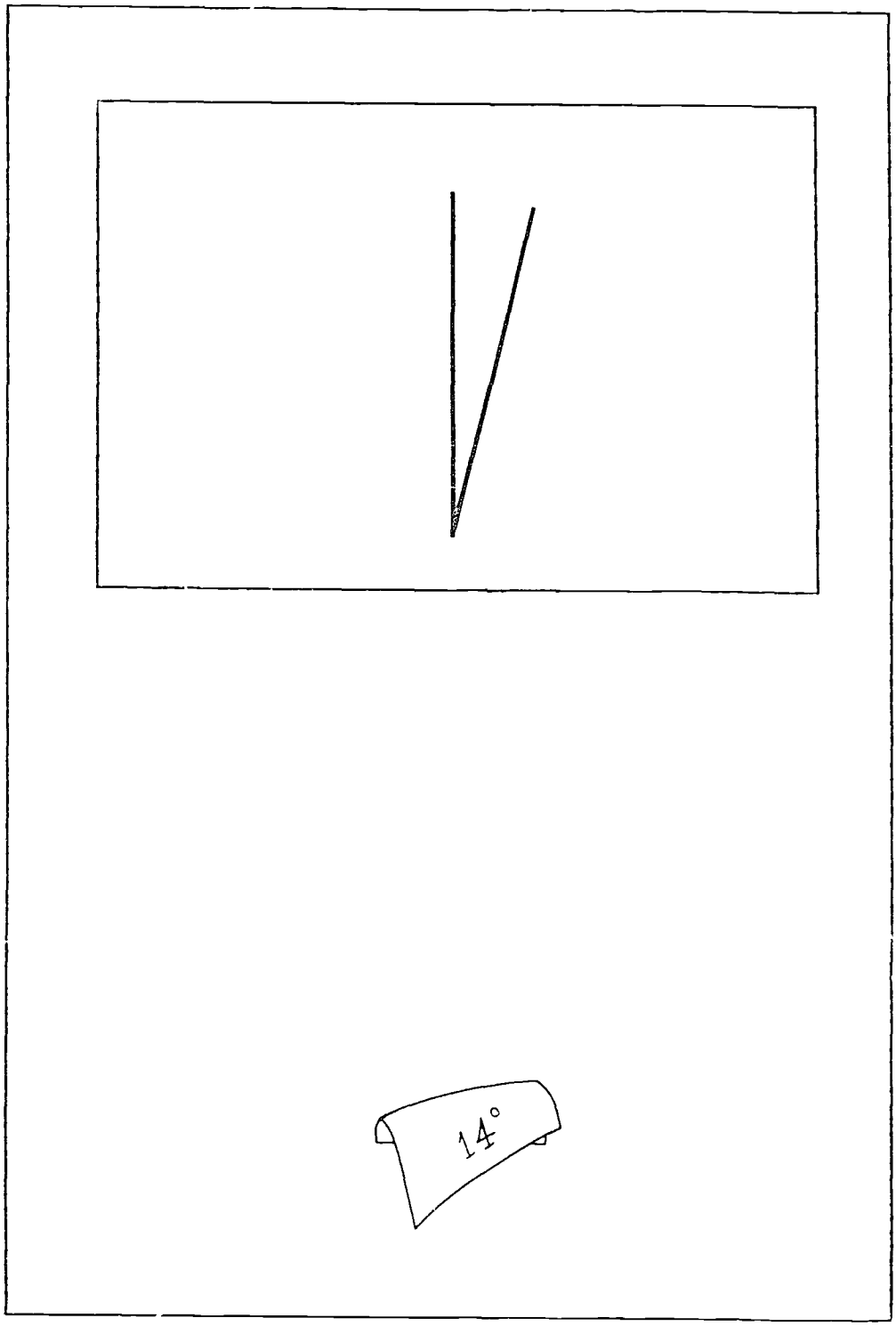


Figure 2

THE ANGLE ESTIMATION JOB AID (ACTUAL SIZE)

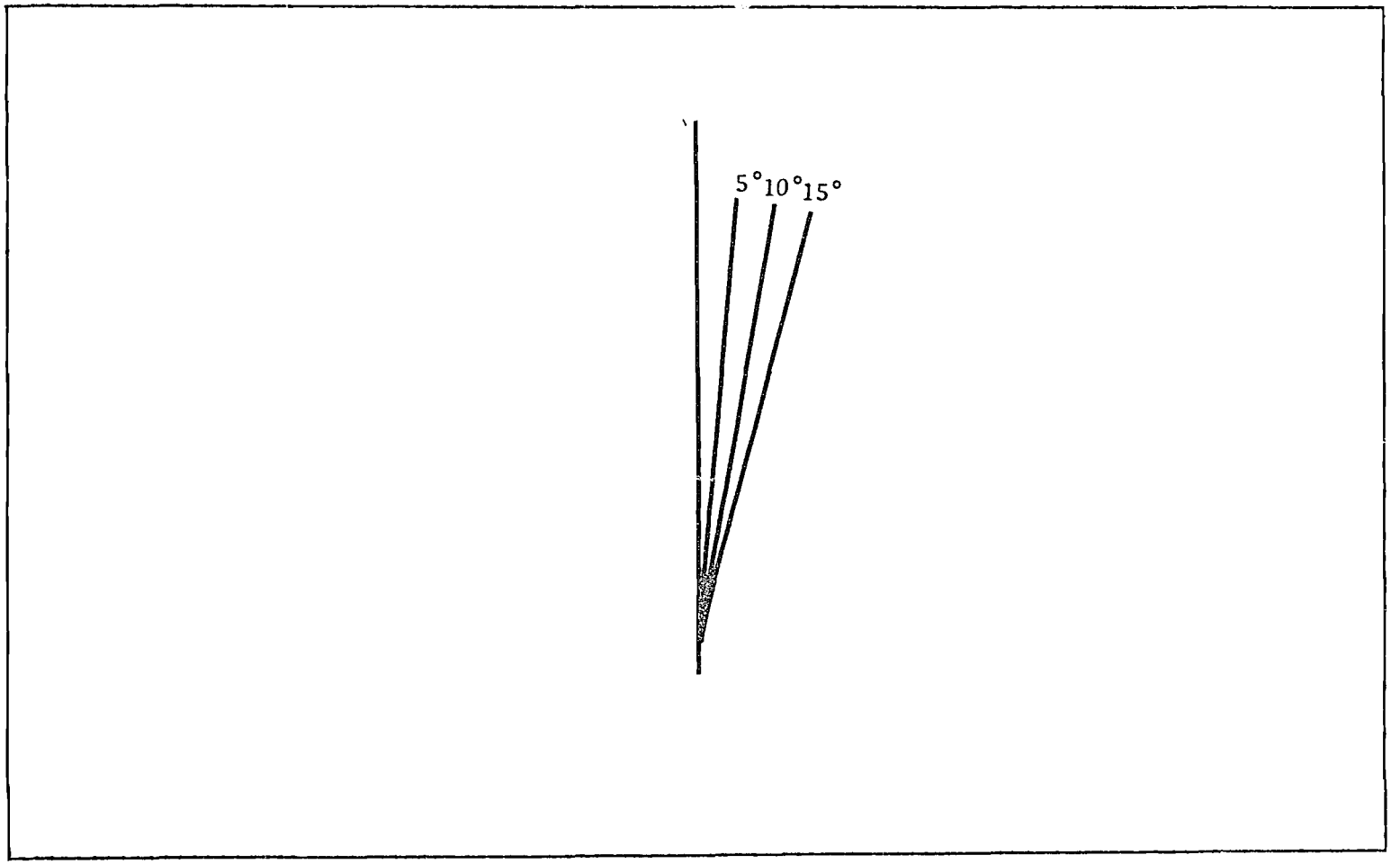


Figure 3

RESULTS

The dependent variable measured was angle estimation error in degrees. *F max* tests[1] indicated that the variances were extremely nonhomogeneous. Therefore, no attempt was made to subject the data to parametric analyses.

Mean absolute error before and after training is shown for each angle size in Figure 4. The "before training" curve includes data for the two training groups on Test 1; the "after training" curve includes data for the same two groups on Test 2. Error increased as angle size increased up to 13°, but decreased slightly on the larger angle sizes. The somewhat greater accuracy in estimating the larger angles may be attributed to the fact that subjects were told in the instructions that no angle would be larger than 18°.

Performance with and without training is reported in Table 1. It shows mean absolute error on Tests 1 and 2 and the ratio of error on Test 2 to that on Test 1 $\left(\frac{\text{Test 2 error}}{\text{Test 1 error}}\right)$, for training and control groups, and for three levels of angle size. At all three levels, the ratio of error was lower for the training groups than for the control group. The ratio of error $\left(\frac{\text{Test 2 error}}{\text{Test 1 error}}\right)$ for all angle sizes combined was .52 for the training groups versus .83 for the control group.

The training groups showed greatest improvement in estimating the small angle sizes; the error ratio increased as angle size increased. For the control group, the error ratio decreased as angle size increased.

Mean absolute error for Groups A, B, and C--the card, card-map, and control groups respectively--is shown in Figure 5 (map items) and Figure 6 (card items). The same data and that for Groups A and B combined are shown in Table 2.

Table 1

MEAN ABSOLUTE ERROR AND ERROR RATIO BY ANGLE SIZE

Angle Size (degrees)	Training Groups			Control Group		
	Mean Error (degrees)		Error Ratio	Mean Error (degrees)		Error Ratio
	T1	T2	T2/T1	T1	T2	T2/T1
1 - 5	1.21	.53	.44	.97	.94	.97
6 - 10	2.64	1.30	.49	2.16	1.79	.83
11 - 15	2.98	1.72	.58	3.28	2.42	.74
All Angles	2.33	1.20	.52	2.16	1.81	.83

[1] B.J. Winer, *Statistical Principles in Experimental Design*, McGraw-Hill Book Company, Inc., New York, 1962.

MEAN ABSOLUTE ERROR BEFORE AND AFTER TRAINING

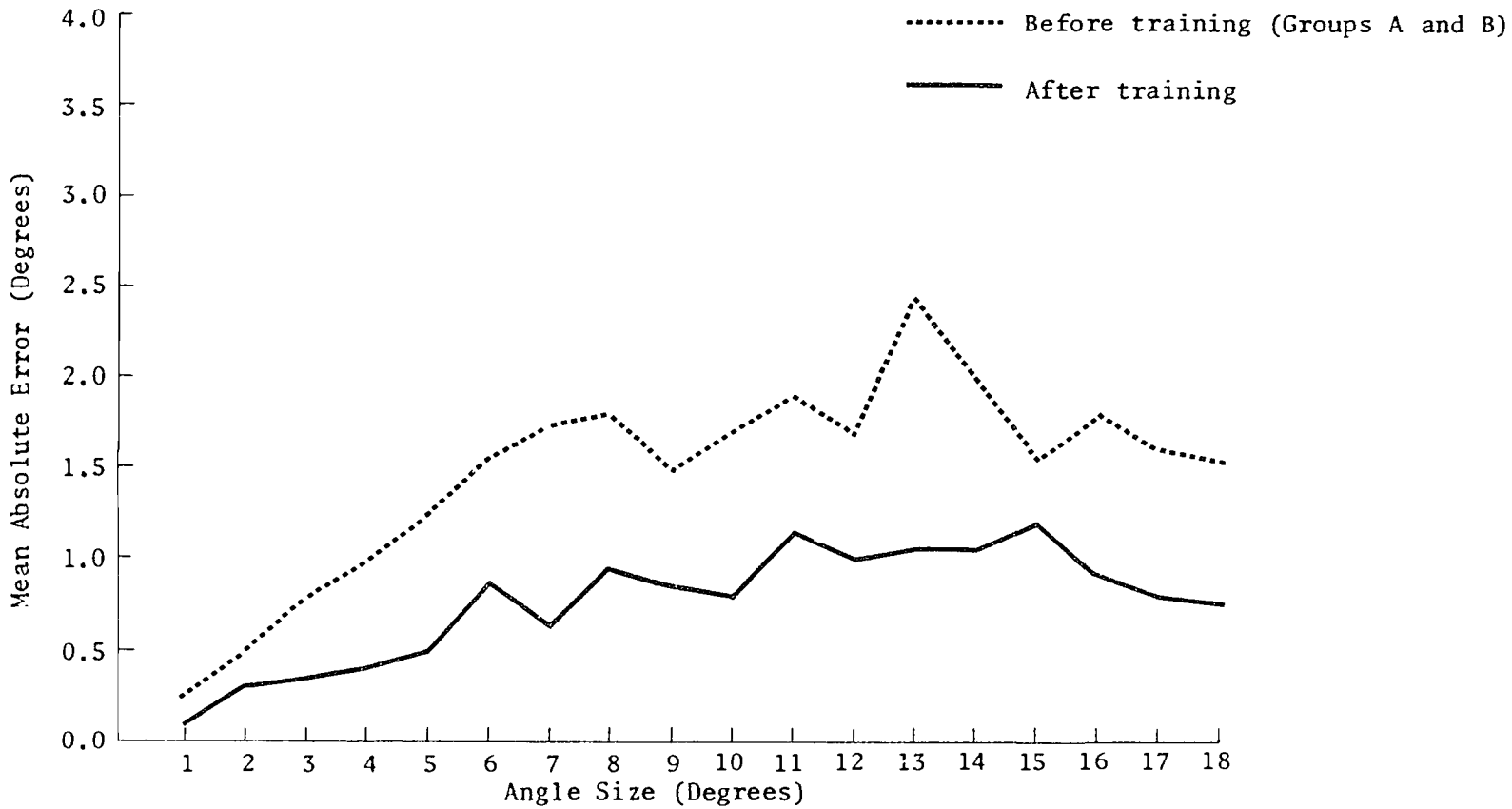


Figure 4

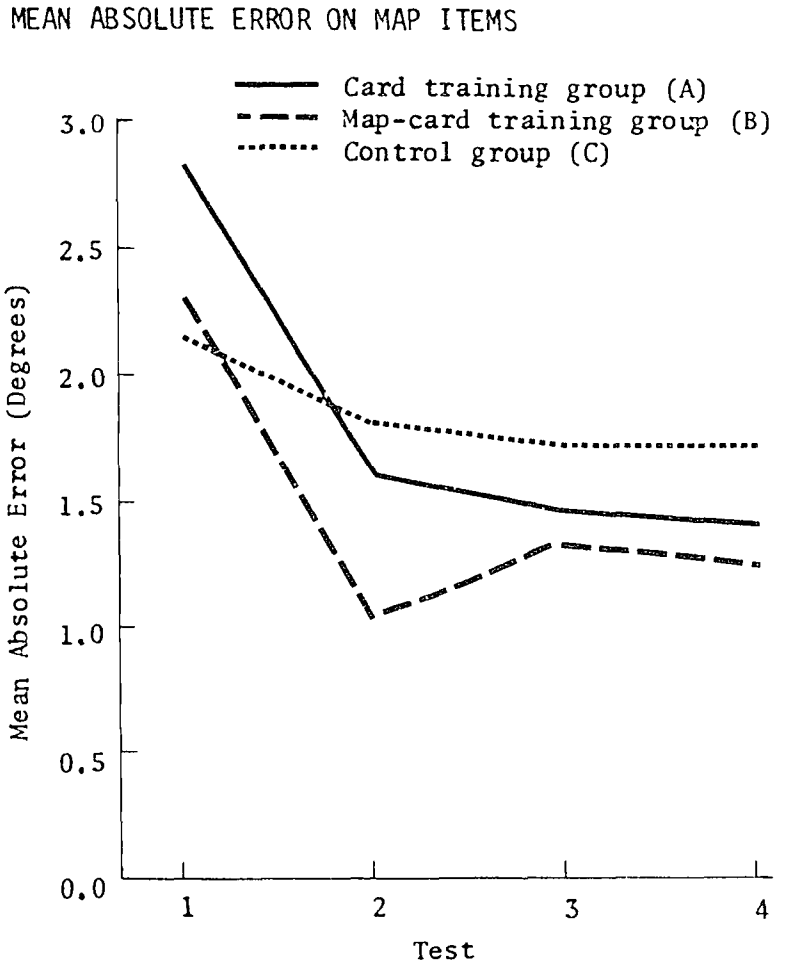


Figure 5

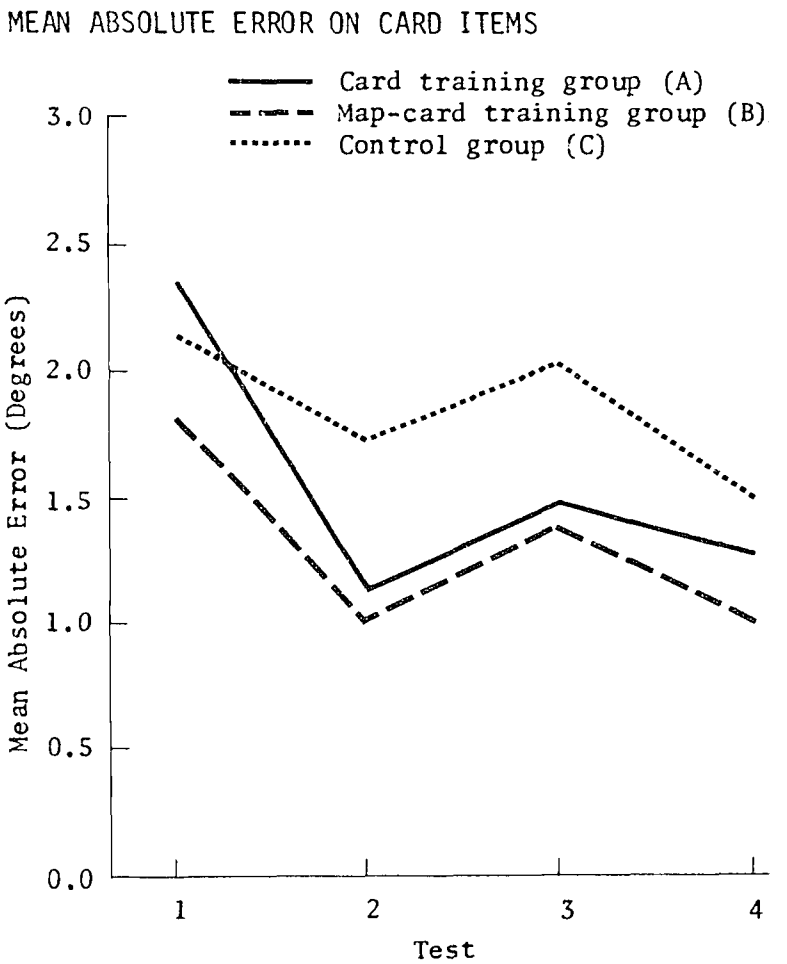


Figure 6

Table 2

MEAN ABSOLUTE ERROR ON MAP AND CARD ITEMS

Group	Map Items (mean error in degrees)				Card Items (mean error in degrees)			
	T1	T2	T3	T4	T1	T2	T3	T4
A	2.82	1.61	1.48	1.41	2.38	1.11	1.48	1.26
B	2.31	1.06	1.34	1.27	1.80	1.02	1.36	1.02
A & B	2.57	1.34	1.41	1.34	2.09	1.07	1.42	1.14
C	2.17	1.84	1.76	1.75	2.16	1.77	2.03	1.49

To test for the significance of differences among the four tests, nonparametric Friedman analyses of variance[1] were computed on map items and on card items. The differences were not statistically significant for the control group on either map or card items, though the difference for map items approached the .05 level of significance.

In general, for map items error decreased from Test 1 to Test 2, from Test 2 to Test 3, and from Test 3 to Test 4, although only the decreases from Test 1 to Test 2 were statistically significant at less than the .05 level. The only exception to this decrease in error between tests was from Test 2 to Test 3 for Group B. For card items, error decreased from Test 1 to Test 2, increased from Test 2 to Test 3, and decreased from Test 3 to Test 4.

The immediate effects of the training programs can be seen in Table 2 in the mean error of 2.57° on Test 1 and of 1.34° on Test 2 for the combined training groups. This is a 48% reduction in error.

Nonparametric sign tests[2] were computed for the differences between pairs of tests for each of the three groups separately and for the two training groups combined. On map items, error on Tests 2, 3, and 4 was significantly lower than error on Test 1, in most cases. Test 2 did not differ significantly from Test 3 or 4; Test 3 did not differ significantly from Test 4. Specific probabilities for the differences between pairs of tests on both map items and card items are shown in Table 3.

To facilitate comparison of the three groups on Tests 2, 3, and 4, mean errors on Test 2, Test 3, and Test 4 were converted to the ratio of mean error on Test 1. The error ratio on map items is shown in Figure 7; the error ratio on card items is shown in Figure 8. The error ratio for the training groups was lower than the error ratio for the control group on all tests for both card items and map items.

[1] S. Siegel, *Nonparametric Statistics for the Behavioral Sciences*, McGraw-Hill Book Company, Inc., New York, 1956.

[2] *Op. cit.*

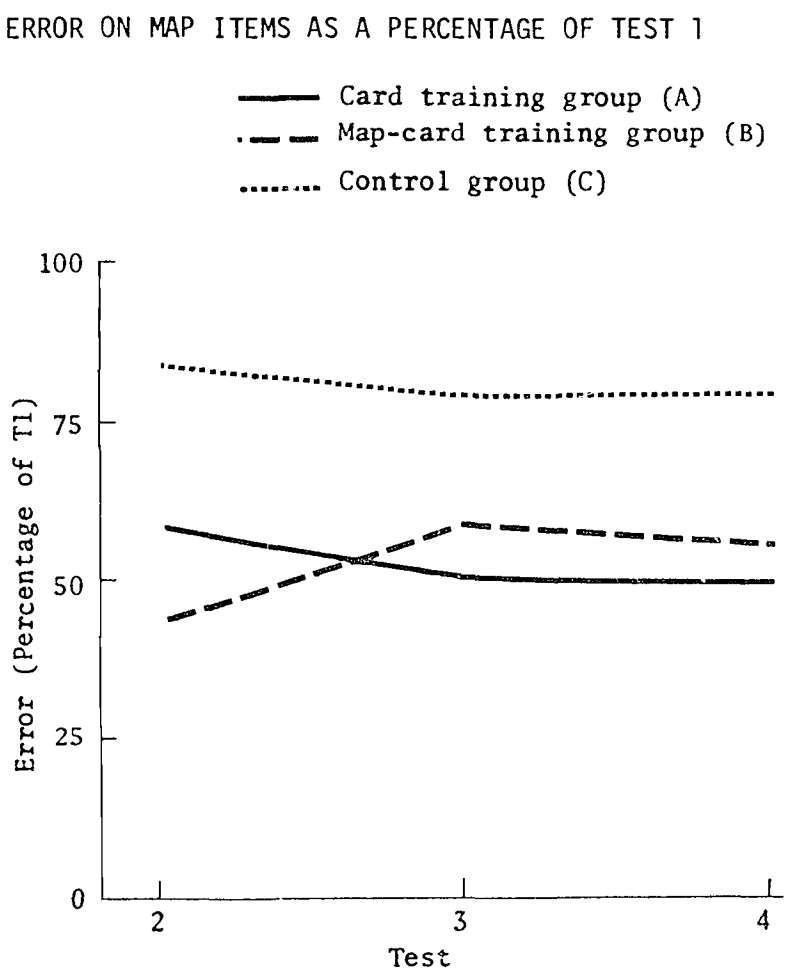


Figure 7

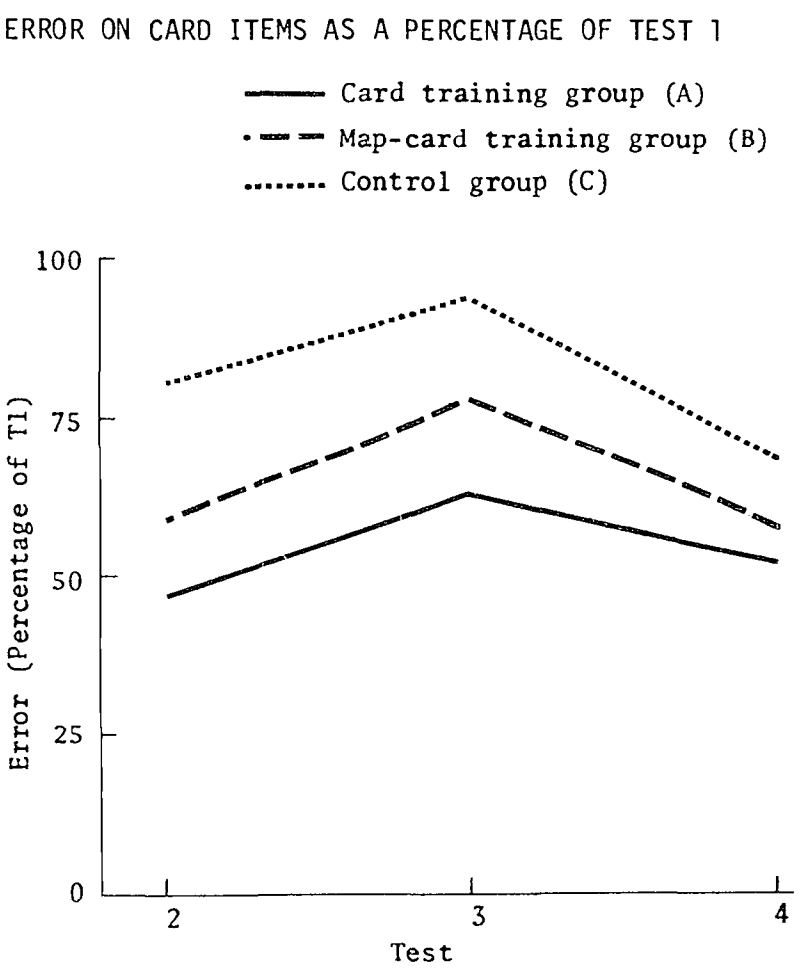


Figure 8

Table 3

PROBABILITY LEVELS FOR DIFFERENCES BETWEEN PAIRS OF TESTS[a]

Group	Test	Map Items			Card Items		
		T2	T3	T4	T2	T3	T4
Card Training Group (A)	T1	.03	.22	.03	.03	.69	.22
	T2		.69	.69		.22	.69
	T3			.69			.38
Card-Map Training Group (B)	T1	.03	.03	.03	.03	.69	.03
	T2		.22	.22		.22	.69
	T3			.99			.69
A and B Combined	T1	.01	.01	.01	.01	.39	.01
	T2		.77	.77		.04	.39
	T3			.77			.23
Control Group (C)	T1	.06	.22	.06	.22	.69	.22
	T2		.69	.38		.99	.22
	T3			.99			.38

[a]*Probabilities are based on results of a sign test.*

Mann-Whitney *U* tests[1] on the ratio data indicated that test performance of the two training groups on map items was significantly superior to test performance of the control group on map items for Tests 2, 3, and 4. On card items there were no significant differences between the two training groups and the control group. There were no significant differences between the two training groups on either card items or map items. Specific probability levels for the differences between pairs of groups are shown in Table 4.

These results have been based on magnitude of error without consideration of direction of error, that is, overestimation or underestimation of angle size. Figures 9 and 10 and Table 5 show mean algebraic error for the three groups for map and card items, respectively. These data show that training produced differential effects on map and card item performance. On Test 1 both training groups tended to underestimate angle size for both map and card items. After training, the training groups continued to underestimate angles on Test 2 and Test 3 for card items, but changed to overestimating on map items. The differences in post-training performance between map and card items were tested by *t* test and found to be significant for both Test 2 and Test 3 ($p<.01$).

Figure 11 shows mean algebraic error by angle size on Tests 2 and 3 combined for the two training groups combined. These data indicated that after training, over the range of angle sizes

[1]S. Siegel, *Nonparametric Statistics for the Behavioral Sciences*, McGraw-Hill Book Company Inc., New York, 1956.

MEAN ALGEBRAIC ERROR ON MAP ITEMS

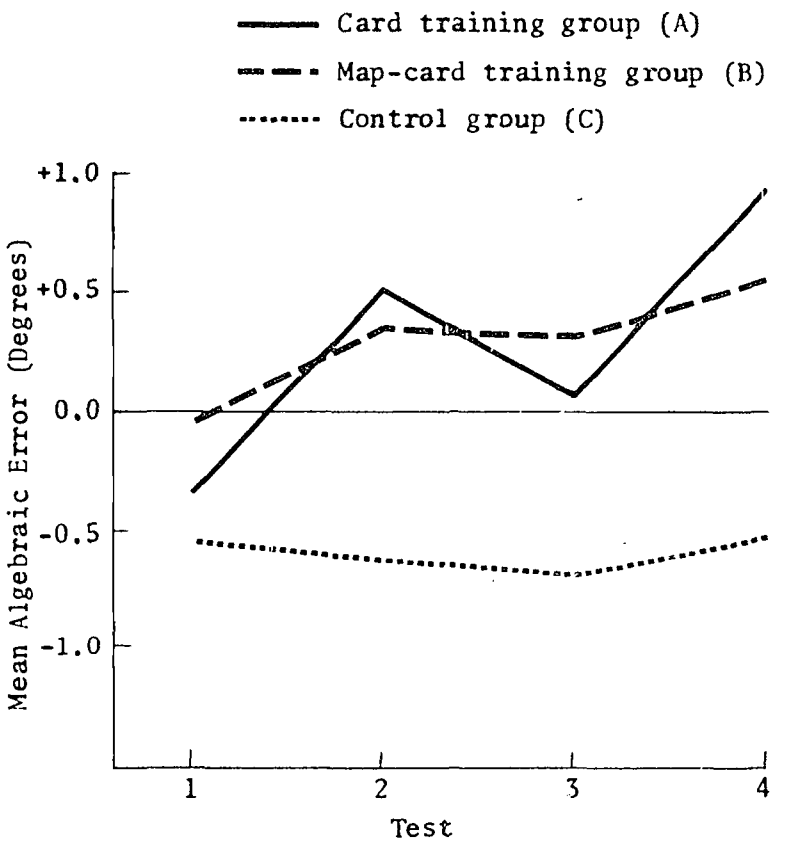


Figure 9

MEAN ALGEBRAIC ERROR ON CARD ITEMS

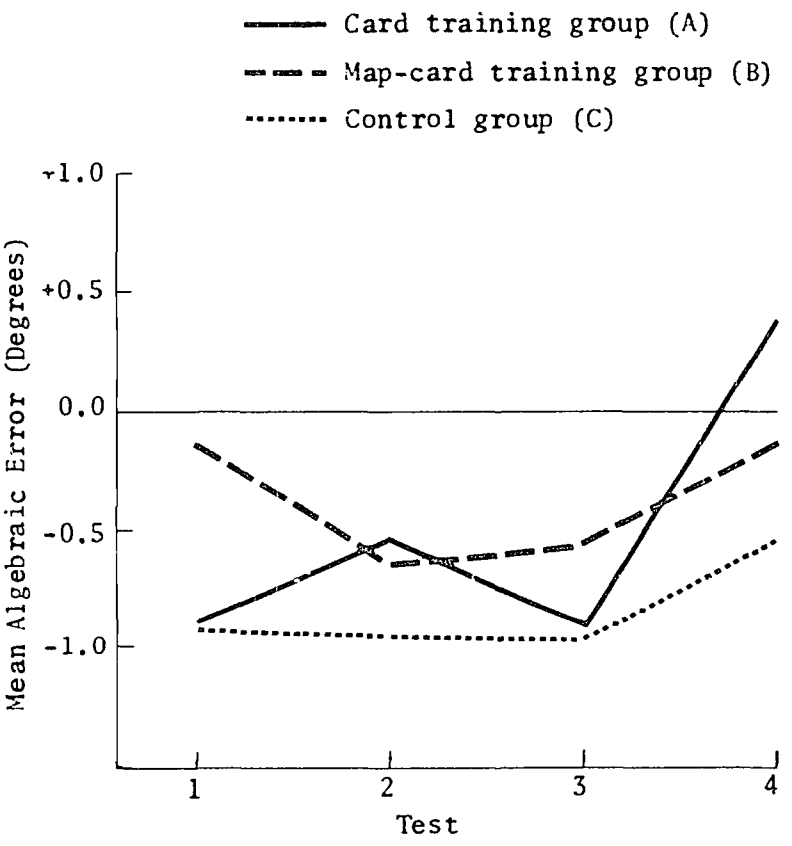


Figure 10

MEAN ALGEBRAIC ERROR AFTER TRAINING FOR MAP AND CARD ITEMS BY ANGLE SIZE

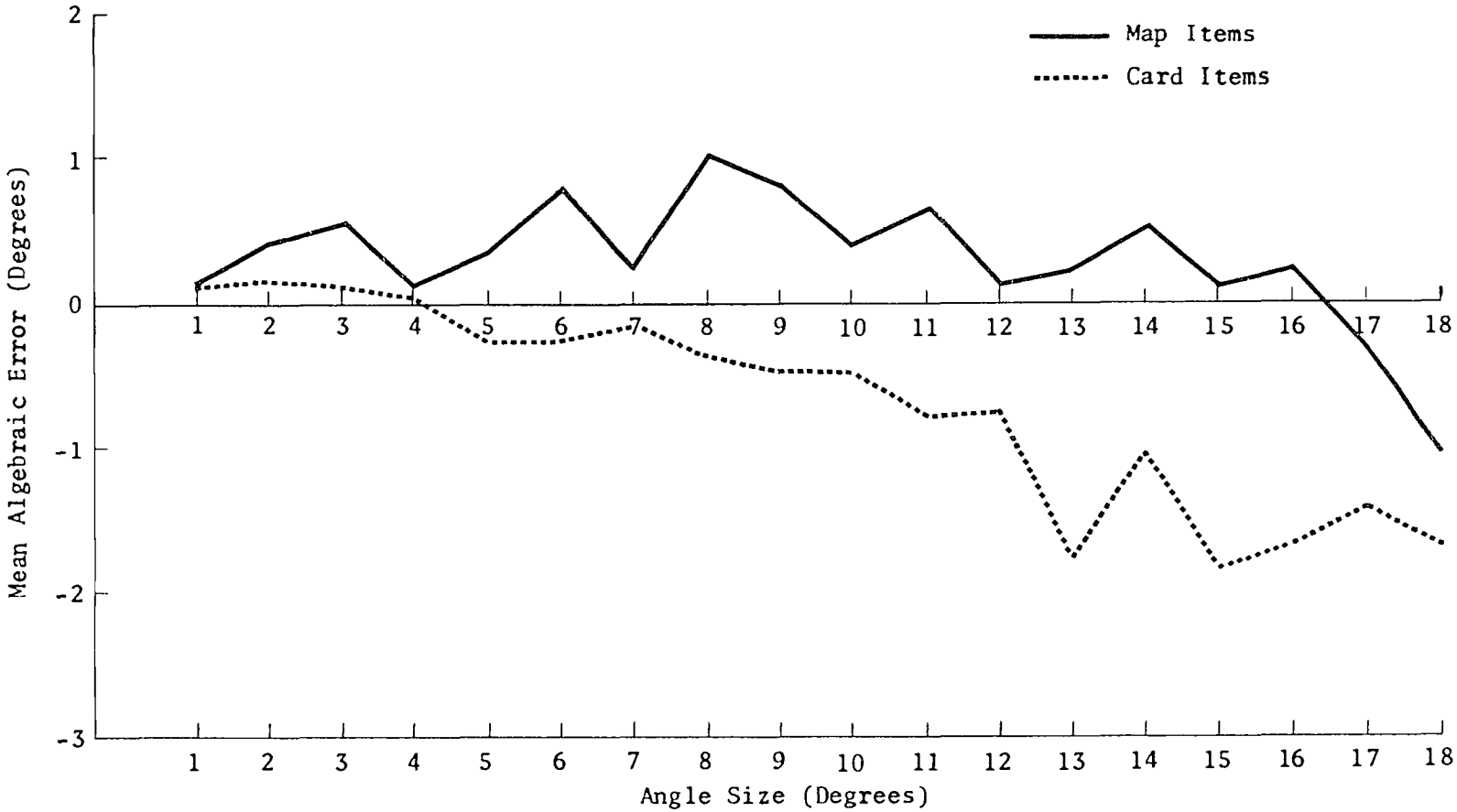


Figure 11

Table 4

PROBABILITY LEVELS FOR DIFFERENCES BETWEEN TRAINING AND CONTROL GROUPS FOR PERFORMANCES ON TESTS 2, 3, AND 4 AS COMPARED WITH TEST 1[a]

Test Compared with T1	Group	Map Items		Card Items	
		B	C	B	C
T2	A	.20	.07	.47	.16
	B		.09		.35
	A&B		.05		.17
T3	A	.41	.09	.47	.29
	B		.12		.41
	A&B		.06		.29
T4	A	.35	.02	.35	.47
	B		.07		.24
	A&B		.02		.29

[a]*Probabilities are based on a Mann-Whitney U test.*

Table 5

MEAN ALGEBRAIC ERROR ON MAP AND CARD ITEMS

Group	Map Items				Card Items			
	T1	T2	T3	T4	T1	T2	T3	T4
A	-.36	+.52	+.08	+.94	-.89	-.56	-.90	+.35
B	-.04	+.35	+.32	+.55	-.20	-.66	-.58	-.19
A & B	-.20	+.43	+.20	+.75	-.55	-.61	-.74	+.08
C	-.52	-.63	-.70	-.51	-.93	-.95	-.95	-.56

studied, there was a generally consistent tendency toward underestimation of the size of angles for card items and toward overestimation for map items.

Figure 10 shows that the underestimation tendency for card items changed to overestimation on Test 4, apparently as a result of using the job aid. A *t* test on the difference between Test 3 and Test 4 indicated it to be significant ($p<.01$).

The performance of the control group, by contrast, remained consistent over all four tests. The control group tended to underestimate angle size.

DISCUSSION

Subjects in this experiment exhibited different levels and patterns of performance on map items as compared to their performance on card items. In actual practice, the pilot's task is to

determine heading changes from information presented on a map. Therefore, test performance on map items provides the most relevant basis for a decision on the feasibility of using direct estimation as a technique for determining correction angles.

The performance of both training groups on map items improved markedly after training. Before training, subjects estimated angle sizes on maps with a mean error of 2.57°. Immediately following training, the same subjects estimated angles on maps with a mean error of 1.34°, for a reduction in error of 48%. The control group showed only about 15% reduction in error on the second test.

The slight improvement of the control group with the practice provided by testing probably derives from the fact that all subjects were informed in the initial instructions that no test angle would be larger than 18°. Since the subjects in the control group knew that the largest angle was 18°, as the test progressed they probably developed a frame of reference upon which they based their later judgments. Therefore, it is not surprising that the control group showed a slight, though not significant, decrease in estimation error.

In this connection, it may be noted that the overall test results (Table 1) showed that for the trained subjects the $\frac{\text{Test 2 error}}{\text{Test 1 error}}$ ratio decreased as angle size increased. The untrained subjects showed very little improvement on retesting for the small angles, but did exhibit a small reduction in error on the large angles. This was probably due to the frame of reference established from the knowledge that the maximum angle size was 18°. Trained subjects, on the other hand, showed an increase in error ratio as angle size increased.

Performance on map items did not significantly deteriorate after one week. The lack of serious deterioration in performance over this period of time was particularly notable because the average training time for subjects in the training groups was only 24 minutes.

Since there were no significant differences between the two training groups on Test 2, 3, or 4, a choice between card and card-map training should be based on something other than the relative performance of the two training groups. In view of the differences in performance that were noted between card and map test items, it would seem desirable to conduct the training program entirely with map items. This would also be in accord with the generally desirable goal of keeping training as realistic as is practical.

The job aid did not improve performance on map items on the fourth test for either of the training groups or for the control group. That performance did not improve was contrary to expectations, particularly for the control group. In this experiment, subjects were not given the job aid until the last test, one week after the training session. Therefore, no conclusion can be drawn relative to the possible effect of providing a job aid before, during, or immediately after training.

Several considerations are important in determining whether or not to provide training in angle estimation to pilots. First, is there any actual value to training? Post-training error on map items was almost 50% lower than pretraining error in this experiment. Such a reduction should be of practical value. Second, mean error after training was only 1° to 1.5°, which indicated that trained subjects should be capable of estimating drift angle sizes with sufficient accuracy for correcting off-course situations. Finally, the training material used in this experiment was relatively simple and inexpensive to prepare, it could be easily distributed and administered, and it was studied for an average of only 24 minutes per subject. Thus, it appears that angle estimation training produces an improvement in skill that is feasible and desirable for operational use.

Though the job aid did not improve performance on map items, use of a job aid might result in maintaining positive training effects over periods of time longer than one week. However, further research would be necessary to establish the value of a job aid over long periods of time or to determine the effects of using the job aid during training. In any case, the cost of providing a suitable job aid would be negligible because the face of a radio compass or gyro compass in the aircraft could serve the purpose.

Appendix

INSTRUCTIONS FOR THE THREE GROUPS

Introduction to the Experiment for All Three Groups

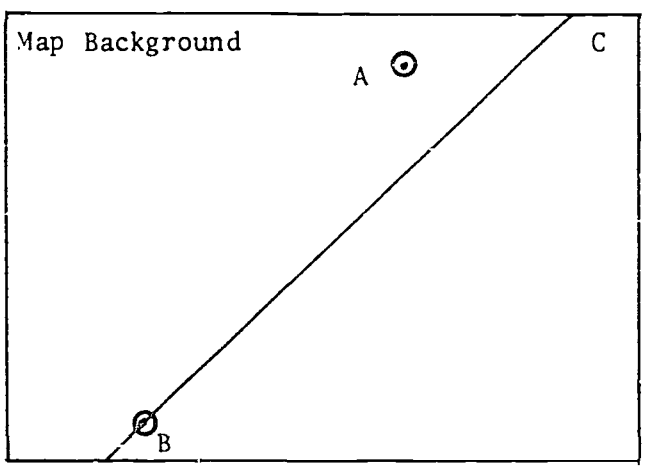
Please open the notebook before you to the first page and follow along as I read the instructions.

The purpose of th experiment in which you are about to participate is to determine how accurately people can identify angle size without the benefit of mechanical aids. Don't let the bulk of the booklets mislead you. Each test lasts only 12 minutes. The entire session will take about an hour, including rest periods and instructions.

You will be given a series of three tests; each test will have 72 items. Each item will consist of an angle presented on a card or map section which you are to examine. When you have examined the angle, you must then write your estimate of the angle size in the proper blank on the answer sheet. All of the angles fall within 1° to 18°. They may be oriented in any direction.

You will be allowed 10 seconds in which to study an angle and record your response. The experimenter will time you. You will find that 10 seconds is more than adequate time. When he says "next" you must move to the next item. There will be two items per page, one on each side. You *must* answer every question. Some of the angles will be drawn on cards and some will be drawn on maps. The angles drawn on maps have only one complete side, but they have a dot with a circle around it to represent the extent of the angle and its origin.

In the example of a map item you can see a straight line drawn across the map, a dot and circle on the straight line labeled B, and a dot and circle away from the line labeled A. You are to estimate the angle which could be formed by ABC. In other words, you are to estimate the size of the angle that would be formed if a line were drawn from A to B. You are to use the center of the dot as a reference point in estimating the angle. The circle around the dot is not accurate but will help you to find the dot.



Example of a Map Item

A heavy black line has been drawn at the origin of every angle on the maps to help you find it. You may find it necessary to search for the dot representing the side of the angle, but you can be sure that it is there somewhere not too far from the line. One full size example of each type item is shown on the next page [see page 5 of this report].

You are to write your answer to the nearest degree. Do not estimate any angle to a half degree.

Do not look back at items already answered. Do not change an answer once you have recorded it. Look at the angle as it is oriented on the page; i.e., don't turn the book sideways.

Remember:

1. You have 10 seconds to answer each question.
2. You must answer every item--a wild guess, if necessary.
3. All angles fall within 1° to 18°, inclusive; i.e., some angles will be 1°, some will be 18°.
4. Estimate by the dot, not by the circle.
5. Your first reaction may be your best bet.
6. Be careful to put your answer in the right blank on the answer sheet.

On the next few pages are five examples of the test questions. Turn to them now and write down your estimate of each one. The experimenter will answer any question that you might have. You will *not* be told the size of the angle on the examples or on any of the test questions.

[At this point, five examples were presented.]

Remember:

1. You have 10 seconds to answer each question. I will indicate when you are to go to the next item by saying "Next."
2. You must answer every item--a wild guess, if necessary.
3. All angles fall within 1° to 18°, inclusive; i.e., some angles will be 1°, some will be 18°.
4. Estimate by the dot, not by the circle.
5. Your first reaction may be your best bet.
6. Be careful to put your answer in the right blank on the answer sheet.

If you have any questions, ask the experimenter now. Once the test begins, please do not talk. If you are positive that you understand the procedure, tell the experimenter now, and get ready to start. Do not turn to the first item until the experimenter says "Go."

Instructions for the Study Session for the Training Group

This is not a test; this is a study session. The purpose of this study session is to help you learn to recognize the size of angles from 1° through 18°. First, you will be shown three angles, 5°, 10°, and 15° in two different orientations. You may compare them as long as you wish. Then, you will be given a series of

angles to identify. As you look at each angle and estimate it, write down your estimate in the first blank opposite the corresponding number on the answer sheet. Next, lift up the tab at the bottom of the page. Under the tab will be shown the correct size of the angle. Read the correct size and look at the angle again. If you have identified the angle correctly, go right on to the next one. If you did not identify the angle correctly, draw a line through your incorrect answer. Then, write the correct answer in the second space on the answer sheet. When you have done that, go on to the next question.

Some of the items will be on cards, and some will be on maps.[1] Don't worry about how close you come to being correct. You will not be timed on each item, but your total time for the study session will be recorded. Work as accurately as you can, but do not waste time. Remember, you can look at the first set of angles as long as you like, but you may not turn back to it. Nor may you turn back to any angle which you have already identified.

In summary, your procedure is this:

A. Study the first set of angles.
B. Study the series that follows.
    1. Look at an angle and estimate its size.
    2. Record your estimate in the first space on the answer sheet.
    3. Lift up the tab and read the correct size.
    4. If correct, proceed to the next angle.
    5. If incorrect, look at the angle again.
    6. Cross out your wrong response and write the correct size in the second space.
    7. Proceed to the next question.

If you have no questions about the study procedure, you may begin. Be as accurate as possible, but do not waste time.

Instructions for the Control Group

For the next 30 minutes you are to rest and engage in activities unrelated to angle recognition.

For the first five minutes you will be free to do whatever you please. You may read, get some coffee, or just wait; but you are not to do anything related to angles or angle recognition.

Then for 20 minutes you *must* sit at the table. You may look at the *National Geographic* magazines or you may sit quietly, but you must sit at the table.

For the last five minutes you will again be free to do whatever you wish within the limits stated above.

Do you have any question about the next 30 minutes?

Instructions for T3 for All Three Groups

This test will be conducted just like the first test you had last week. There are 72 items; you will be given 10 seconds on

[1] For the group trained on cards, this sentence was changed to read: "All of the items will be on cards."

each one. I will indicate when you are to go to the next question by saying "Next."

Do not change answers or use your pencil as a measuring aid.

Instructions for T4 for All Three Groups

On this last test you will be provided a card with three angles drawn on it: 5°, 10°, and 15°. You may keep this card before you throughout the test and use it as a reference. Please notice that the sides of the angles on the reference card are shorter than the sides of the angles on the tests. Before the test begins you may examine the reference card as closely as you wish. However, once the test begins please do not move it from its position on the table, nor move from your chair to get closer to the card.

Except for the use of the card, the procedure on this test will be the same as on previous tests. You will, as before, be given 10 seconds on each item. Please do not change answers.

Any questions?

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13. ABSTRACT

This study examined the feasibility of using direct perceptual estimation on maps to determine angles of drift, and the effect of training on this ability. Subjects were divided into a control group and two training groups, one of which was trained using angles drawn on plain white cards, and the other using angles drawn on both cards and tactical maps. Both training groups initially estimated the size of angles, ranging from 1° to 18°, with a mean absolute error of 2.57° and a mean algebraic error of -0.20°. After training, absolute error was 1.34° and algebraic error was +0.43°. A job aid consisting of reference angles of 5°, 10°, and 15° did not significantly affect performance on map items, although on card items, performance of the training groups shifted from underestimation to slight overestimation of angle size.

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1 SPCY OF ARMY
1 DCS-PERS DA ATTN CHF C+S DIV
2 DACS FOR INTEL DA ATTN CHF CBT INTEL DEVEL DIV
1 CO FOREIGN SCI + TECH CTR MUN BLDG
2 ASS FOR FORCE DEVEL DA ATTN CHF TNG DIV
1 CHF OF ENGNRS DA ATTN ENGTE-T
1 HQ ARMY MAT COMD R+D DRCTE ATTN AMCRD-DE
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4 CO 2D ARMORED CAV REGT APO 696 NY
1 CO 3D ARMORED CAV REGT APO 34 NY
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8 4TH INF DIV 2D BN 68TH ARMOR APO 34 NY
1 CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV (SPEARHEAD) APO 39 NY
1 CO 5TH BN 33D ARMOR FT KNOX
1 CO 3D MED TANK BN 68TH ARMOR APO 28 NY ATTN S3
1 CO 3D MED TANK BN 37TH ARMOR APO 36 NY
1 CO 4TH MED TANK BN 68TH ARMOR APO 34 NY
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2 CO 3D MED TANK BN 32D ARMOR APO 29 NY
1 CG ARMY ARMOR CTR FT KNOX ATTN G3 AIRBGT
2 CG 1ST INF DIV FT RILEY ATTN G3
1 CG 2D INF DIV FT BENNING ATTN DIV AVN COMDR
3 CG 4TH INF DIV FT LEWIS ATTN G3
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4 CO 1ST BN (MECH) 52D INF (ST ARMORED DIV (OLD IRONSIDES) FT HOOD
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1 CHF MED RES PROJ ARMY HOSP US MILIT ACAD WEST POINT
1 CG MILIT DIST OF WASHINGTON
1 TECH DIR R+D DIV OFC OF QM GEN
2 HQ ARMY LIAISON GP PROJ MICH U OF MICH
1 DIR ARMY LIB
1 STRATEGIC PLANNING GP CORPS OF ENGNR ARMY MAP SERV
1 CHF OF MILIT HIST DA ATTN CEN REF RS
1 82D ABN DIV FT BRAGG
4 HQ 40TH ARTY BRGD AIR DEF PRES OF SAN FRAN
1 CO 56TH ARTY BRGD AIR DEF FT BANKS
1 CG 31ST ARTY BRGD AIR DEF OAKDALE PENNA
1 24TH ARTY GP AIR DEF FT LAWTON
2 HQ 47TH ARTY HAMPTON RDS ARMY TERM NORFOLK
1 2RTH ARTY GP AIR DEF SELFRIDGE AFB
1 52D ARTY BRGD AIR DEF HIGHLANDS AFS
1 HQ 45TH ARTY BRGD AIR DEF ARLINGTON HTS ILL
1 35TH ARTY BRGD AIR DEF FT GEO G MEADE
2 CO ARMY AVN TEST BD FT RUCKER
1 CG 101ST ABN DIV FT CAMPBELL
1 CG 1ST CAV DIV APO 24 SAN FRAN
1 ARMY QM R+F FEA FT LEE ATTN TECH LIB
1 CHF RDH&V SCI REF RS 3D ARMY MED R+D COMD
2 PRES ARMY FINANCE CORPS BR
1 ARMY R+D OFC PANAMA FT CLAYTON CANAL ZONE ATTN RDHAV SCI COORD
2 CINC US PACIFIC FLT PRP SAN FRAN
1 CINC PACIFIC OPNT ANLS SECT PRP SAN FRAN
1 CHF RHP OF MED + SURG DN ATTN CODE 513
1 HEAD GLEN PSYCHOL SECT PROFESNL DIV BUR OF MED + SURG DN
1 BUR OF NAV PERS ATTN TECH LIB PERS 11B
3 DIR PERS RES DIV BUR OF NAV PERS
3 CHF OF NAV PERS
1 CHF OF NAV PERS ATTN PERS-C1124
1 CO + DIR NAV TNG DEVICE CTR PT WASHINGTON ATTN LIBN
2 NAV MSL CTR POINT MUGU CALIF ATTN HUMAN FACTORS ENGNR DIV
1 CO NAV AIR DEVEL CTR JOHNSVILLE PENNA ATTN NAVTADEVCEN LIB
2 FLT ANTI-AIR WARFARE TNG CTR DAM NECK VA BRANCH
2 CO FLT TNG CTR NAV BASE NEWPORT
2 OIC ATLANTIC FLT MSL WEAPON SYS TNG UNIT FLT ANTI-AIR WARFARE TNG CTR
DAM NECK VA BRANCH

2 CO FLT TNG CTR NORFOLK
2 HUMAN FACTORS DEPT COMM PSYCHOL DIV NAV TNG DEVICE CTR PT WASHINGTON
1 CLIN PSYCHOL MENTAL HYGIENE UNIT US NAV ACAD ANNAPOLIS
1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIB
2 CO + DIR ATLANTIC FLT ANTI-SUB WARFARE TACTICAL SCH NORFOLK
1 CO NUCLEAR WEAPONS TNG CTR ATLANTIC NAV AIR STA NORFOLK
2 CO FLT ANTI-AIR WARFARE TNG CTR DAM NECK VA BEACH
2 CO FLT SONAR SCH KEY WEST
1 CHF OF NAV RES ATTN HEAD PERS + TNG BR CODE 458
1 CHF OF NAV RES ATTN DIR PSYCHOL SCI DIV CODE 450
1 CHF OF NAV RES ATTN HEAD OP PSYCHOL BR CODE 452
1 OIC NAV PERS [illegible] ES ACTVY NAV YD WASHINGTON
5 CO OFC OF [illegible] V RES BR OFC FPO 39 NY
1 CHF OF N[illegible] AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
1 CO NAV SCH [illegible] F AVN MED NAV AVN MED CTR PENSACOLA
1 CO MED FLD RES LAB CAMP LEJEUNE
1 CDR NAV MSL CTR POINT MUGU CALIF ATTN TECH LIB CODE 3022
2 OIC NAV PERS RES ACTVY SAN DIEGO
1 NAV AIR TECH TNG CTR MEMPHIS
1 NAV NEUROPSYCHIAT RES UNIT SAN DIEGO
2 CDR NAV MSL CTR POINT MUGU CALIF ATTN HUMAN ENGNR DIV CODE N-335
1 OIC NAV PERS RES ACTVY NAV STA NAV YD ANNEX WASHINGTON
1 NAV TNG PERS CTR NAV STA NAV YD ANNEX WASHINGTON ATTN CODE 9 LIB
2 CONTRL NAV BASE NORFOLK
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS EDUC CTR MARINE CORPS SCH QUANTICO
ATTN SECRET + CONF FILES GP
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV OPNS OP-01P1
1 CHF OF NAV OPNS OP-03T
1 CHF OF NAV OPNS OP-07T2
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
2 COMDT PTP COAST GUARD HQ
1 CHF OPER PERS RES + REVIEW BR COAST GUARD HQ
1 OPNS ANLS OFC HQ STRATEGIC AIR COMD OFFUTT AFB
1 AIR TNG COMD RANDOLPH AFB ATTN ATFTM
1 DIV OF PERS PROCUR + RETENTION AIR FORCE MILIT PERS CTR RANDOLPH AFB
1 HQ AIR FORCE ATTN AFCIN-3D1
1 CHF SCI DIV DRCIE OF SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
1 CHF SPEC WARFARE DIV DRCIE OF PLANS + OPNS DCS-PLANS+OPNS
HQ AIR FORCE
1 CHF OF PERS RES BR DRCIE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
1 CHF EVAL ARIAFPDPCEI CAREER DEVEL DIV DRCIE OF PERS PLAN HQ AIR FORCE
1 AIR FORCE STAFF COLL SCI + TECH LIAISON OFC (RTSNW) CO ON
1 CHF COMM STUDY GP SAFOIXO BOLLING AFB STOP A-20
1 FED AVN AGY MED LIB HQ-640
2 HQ AIR FORCE STAFF COLL SCGB 3 ANDREWS AFB
1 ROME AIR DEVEL CTR RASM GRIFFISS AFB
2 CDR ELEC SYS DIV L G HANSCOM FLD BEDFORD MASS ATTN ESRHO
2 SACRAMENTO AIR MAT AREA SMACU-PERS RES MCCLELLAN AFB
1 AIR TNG COMD ATTNS W RANDOLPH AFB
1 AERO MED RES LAB MRRIO WRIGHT-PATTERSON AFB
1 AIR MOVEMENT DESIGNATOR MRRIO WRIGHT-PATTERSON AFB
1 HQ BALLISTICS SYS DIV PERS SUBSYS BR BSOSP NORTON AFB
2 MILIT TNG CTR DPE LACKLAND AFB
2 AS70TH AEROMED RES LAB MRRT WRIGHT-PATTERSON AFB
1 AIR MOVEMENT DESIGNATOR AMRH BROOKS AFB
1 DCS-TECH TNG DIR MILIT + SPT TNG RANDOLPH AFB
4 HQ AIR TRANS COMD AICTD-M RANDOLPH AFB
1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN ESTI
1 DIR AIR U LIB MAXWELL AFB ATTN AUL3T-63-253
1 AIR FORCE SCH OF AEROSPACE MED BROOKS AFB ATTN AEROMED LIB
1 DIR OF LIB US AIR FORCE ACAD
1 COMDR ARCTIC AEROMED LAB APO 731 SEATTLE
1 6570TH PERS RES LAB PRA-4 AEROSPACE MED DIV LACKLAND AFB
1 TECH TNG CTR IMT LOWRY AFB
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN DIR OF TNG
3 CENTRAL INTEL AGY ATTN OCR MAIL RM
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF REGL TNG BR TNG DIV FED AVN AGY ATTN PT 3A
1 CHF PERS RES STAFF OFC OF PERS DEPT OF AGRICUL
1 RES INFO CTR NATL BUR OF STANDARDS ATTN RES PSYCHOL
1 CHF PSYCHOL BR CIVIL AEROMED RES INST FED AVIA AGY OKLAHOMA CITY
1 SYS DEVEL CORP SANTA MONICA ATTN LIB
2 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RES ANLS CORP BETHESDA
1 RAND CORP WASHINGTON ATTN LIB
1 U OF ILL GP EFFECTIVE RES LAB
2 U OF SO CALIF ELEC PERS RES GP
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
1 WESTERN ELECTRIC CO WINSTON-SALEM
2 U OF PGH LEARNING R+D CTR ATTN DIR
1 HUMAN SCI RES INC NORFOLK
1 WESTERN ELECTRIC CO INC NY
1 HUMAN ECOLOGY FUND WASHINGTON
1 HUMAN SCI RES INC MCLEAN VA
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
1 SORO AMER U ATTN LIBN
1 RAYTHEON CO ELEC SERV OPNS BURLINGTON MASS
2 EDUC + TNG CONSULTANTS LOS ANGELES ATTN PRINCIPAL SCI
1 INFO SYS DEPT 197 SPACE + INFO SYS DIV N AMER AVN INC DOWNEY CALIF
1 GEN DYNAMICS POMONA CALIF ATTN LIB
1 BELL AEROSYS CO CASTLE AFB
1 AVN CRASH INJURY RES SKY HARBOR AIRPORT PHOENIX ATTN TECH LIBN
2 MARQUARDT CORP POMONA CALIF ATTN DEPT 580
1 REFLECTONE ELEC INC STAMFORD CONN
1 CHF PERS SUBSYS AIRPLANE DIV MS 74-90 RENTON WASH
1 SYLVANIA ELECTRIC PRODUCTS INC NEEDHAM HGTS MASS ATTN PERS SUBSYS MANGR
1 THIOKOL CHEM CORP HUMETRICS DIV LOS ANGELES ATTN LIBN
2 SORO FLD OFC OFC OF SECY SPEC WARFARE SCH FT BRAGG
1 DIR OF RELIABILITY + VALUE ENGNR BELL AEROSYS CO BUFFALO
1 INST FOR DEF ANLS RES + ENGNR SUPPORT DIV WASHINGTON
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 OHIO STATE U
1 EDITOR TNG RES ABSTR AMER SOC OF TNG DIRS U OF TENN
1 U OF CHICAGO DEPT OF SOC
1 GEO WASHINGTON U DEPT OF PSYCHOL
1 HUMAN FACTORS SECT R+D GEN DYNAMICS ELECTRIC BOAT GROTON
1 DIR SORO AMER U
6 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
3 CANADIAN JOINT STAFF DIC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN G502 TNG
2 CANADIAN LIAISON OFCR ARMY ARMOR BD FT KNOX
3 ACS FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
2 ACS FOR INTEL FOREIGN LIAISON OFCR FOR SWEDISH EMBSY ATTN ARMY ATTACHE
1 NATL INST FOR ALCOHOL RES OSLO
2 FRENCH LIAISON OFCR ARMY AVN TEST BD FT RUCKER
1 BRITISH LIAISON OFCR ARMY AVN TEST BD FT RUCKER
1 AUSTRALIAN EMBSY OFC OF AIR ATTACHE WASHINGTON ATTN T A NAVGN SOON LOR
1 YORK U DEPT OF PSYCHOL
2 AUSTRALIAN EMBSY OFC OF MILIT ATTACHE WASHINGTON
2 U OF SHEFFIELD DEPT OF PSYCHOL
1 MENNINGER FOUNDATION TOPEKA
2 AMER INST FOR RES WASHINGTON
1 AMER INST FOR RES PGH ATTN LIBN
1 COLUMBIA U SCH OF BUS
3 MATRIX CORP ARLINGTON ATTN TECH LIBN
1 AMER TEL+TEL CO NY
1 U OF GEORGIA DEPT OF PSYCHOL
1 OBERLIN COLL DEPT OF PSYCHOL
1 GEN ELECTRIC CO SANTA BARBARA ATTN LIB
1 VITRO LABS SILVER SPRING MD ATTN LIBN
1 TENN VALLEY AUTHORITY KNOXVILLE ATTN LABOR RELATIONS OFCR DIV OF PERS
1 U OF GEORGIA DEPT OF PSYCHOL
1 U OF UTAH DEPT OF PSYCHOL
1 AMER INST FOR RES LOS ANGELES
1 AMER INST FOR RES PALO ALTO CALIF
1 MICH STATE U COLL OF SOC SCI
1 N MEX STATE U
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES
1 NORTRONICS DIV OF NORTHROP CORP ANAHEIM CALIF
1 LING TEMCO VOUGHT INC WARREN MICH ATTN HEAD HUMAN FACTORS
2 AIRCRAFT ARMAMENTS INC COCKEYSVILLE MD
1 AMER MACH + FOUNDRY CO GREENWICH ENGNR DIV STAMFORD CONN
2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
1 TUFTS U HUMAN ENGNR INFO + ANLS PROJ
1 AMER PSYCHOL ASSOC WASHING. N ATTN PSYCHOL ABSTR
1 NO ILL U HEAD DEPT OF PSYCHOL
1 GEORGIA INST OF TECH DIR SCH OF PSYCHOL
1 OHIO STATE U DEPT OF AVN
1 REPUBLIC AVN CORP FARMINGDALE LONG ISL ATTN SUPERV ENGNR LIB
1 WASHINGTON ENGNR SERV CO INC KENSINGTON MD
1 LIFE SCI INC FT WORTH ATTN PRES
1 AMER BEHAV SCI NY
1 INTERNATL INVENTORS CONGRESS CHICAGO
2 DIR INSTR RESOURCES STATE COLL ST CLOUD MINN
1 COLL OF WM + MARY SCH OF EDUC
1 SO ILLINOIS U DEPT OF PSYCHOL
2 COMMUNICABLE DISEASE CTR DEVEL + CONSULTATION SERV SECT ATLANTA
1 NORTHWESTERN U DEPT OF INSTR ENGNR
1 NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
1 CHF PROCESSING DIV DUKE U LIB
1 U OF CALIF GEN LIB DOCU DEPT
1 FLORIDA STATE U LIB GIFTS + EXCH
1 HARVARD U PSYCHOL LABS LIB
1 U OF ILL LIB SER DEPT
2 U OF KANSAS LIB PERIODICAL DEPT
1 U OF NEBRASKA LIBS ACQ DEPT
1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PERIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 U OF MINNESOTA LIB
1 STATE U OF IOWA LIBS SER ACQ
1 NO CAROLINA STATE COLL OH HILL LIB
2 BOSTON U LIBS ACQ DIV
1 U OF MICH LIBS SER DIV
1 BROWN U LIB
2 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
1 U OF DENVER MARY REED LIB
2 DIR U LIB GEO WASHINGTON U
2 LIB OF CONGRESS CHF OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 OFC OF DIR CATHOLIC U LIB ATTN PSYCHOL DEPT LIB
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 KANSAS STATE U FARRELL LIB
1 BRIGHAM YOUNG U LIB SER SECT
1 USAOGMS REDSTONE ARSNL ATTN AJO
1 HUM SCI RES LAB INC ARLINGTON
1 CHMN DEPT OF PSYCH GEORGIA INST OF TECHNOLOGY ATLANTA
1 MILIT ACFT SYS DIV BOEING CO SEATTLE
1 CO 24TH DIV (MECH) ARTY AVN SECT APO 29 NY
1 OFC OF THE SURG GEN HQ DA ATTN AVN SECT
1 ARMY TRANS RES COMD FT EUSTIS
1 CHF AVIONICS + NAVIGN ANDS CMDTY OFC ARMY ELEC COMD FT MONMOUTH
1 PLANS OFCR ARMY CDEC FT ORD
1 AVN OFCR ARMY CDEC FT ORD
1 DISPLAY SYS DEPT HUGHES ACFT CO CULVER CITY CALIF
1 CO WRIGHT-PATTERSON AFB
1 CORNELL AERONAUTICAL LAB BUFFALO
1 PGTA OPTY FOR EFFECTIVENESS TEST (PGT) EGLIN AFB
1 NAVAL ORD LAB SILVER SPRING
1 IBM-SPACE GUIDANCE CTR OSWEGO NY
1 AUTONETICS ANAHEIM CALIF ATTN TECH LIB
1 WRIGHT-PATTERSON AFB ATTN SEMCR
1 APL/JOHNS HOPKINS U SILVER SPRING
1 DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
1 DEPT OF PSYCH VANDERBILT U NASHVILLE
1 AVN MED ACCELERATION LAB NAVAL AIR DEVEL CTR JOHNSVILLE PA
1 HUGHES ACFT CO CULVER CITY CALIF ATTN CO TECH DOCU CTR
1 PERS + TNG BR PSYCHOL SCI DIV OFC OF NAV RES